AGR Series Stage Hardware Manual

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Dedicated to the Science of Motion
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NOTE: Aerotech continually improves its product offerings; listed options may be superseded at any time. Refer to the most recent edition of the Aerotech Motion Control Product Guide for the most current product information at www.aerotech.com.

NOTE: All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. The most recent system drawings and schematics can be found on your software CD ROM or on www.aerotech.com.

NOTE: Read this manual in its entirety before installing, operating, or servicing this product. If you do not understand the information contained herein, contact an Aerotech representative before proceeding. Strictly adhere to the statements given in this section and other handling, use, and operational information given throughout the manual to avoid injury to you and damage to the equipment.

NOTE: This product is intended for light industrial manufacturing or laboratory use.

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Chapter 1: Overview

AGR series motorized rotary stages provide significant improvements in speed, load capacity, and long-term positioning performance over previous generations of worm-gear-drive stages. AGR series stages address a wide range of applications for general purpose positioning in laboratory and industrial uses.

The AGR series of worm gear driven rotary stages are available in both continuous and limited travel versions. There are five members of the product family whose apertures range from 50 mm to 200 mm in diameter.

Construction Features

The addition of a larger clear aperture is a key enhancement over previous generations of worm-gear-driven stages. This feature allows the AGR series to address applications requiring a through-hole or accommodations to mount an optic, including articulation of beam polarizing lenses, through-holes for cabling and/or air lines, or vision/camera/inspection applications.

The AGR stage base is fabricated from an aluminum alloy that offers significant weight savings in multi-axis arrangements and other weight critical applications, while providing high structural stiffness and long-term stability.

Each stage is designed with two high-precision angular contact bearings with optimal spacing to provide excellent error motions coupled with high load capacities in a small, compact package.

Flexible Options

Options include flexible motor selections as well as a direct encoder mounted to the stage shaft for outstanding repeatability and to virtually eliminate hysteresis and backlash. Vacuum-compatible versions (for use in pressures as low as 10^{-6} torr) are also available.

Motor and Drives

Standard AGR stage configurations feature Aerotech's brushless servomotors. However, all AGR stages can be outfitted with stepper or DC brush motors. A full range of matching drives and controls are available for a complete single-source solution.

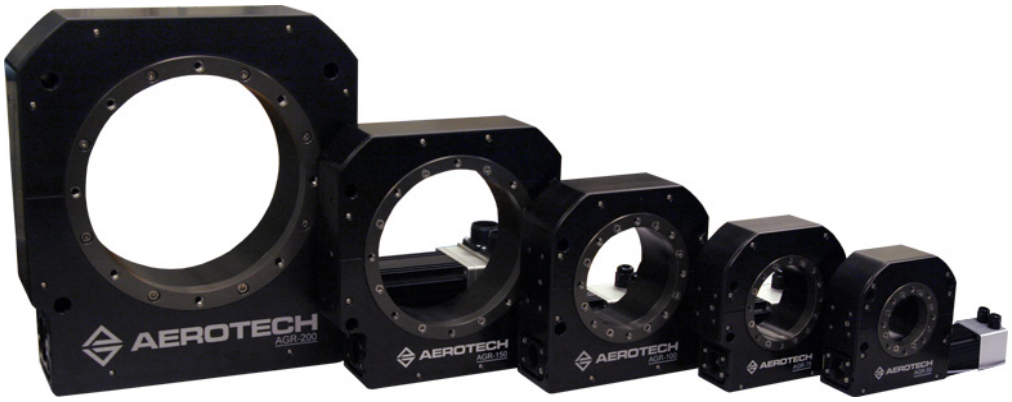


Figure 1-1: Standard AGR Rotary Stages

NOTE: This product is intended for light industrial manufacturing or laboratory use.

1.1. Standard Features

All AGR rotary stages are designed around exceptionally large apertures while maintaining a small footprint. The height of the stage is governed by the NEMA frame size of the mounted motor, minimizing the overall height of the product. Each AGR rotary stage is designed to be mounted with either a vertical or horizontal axis of rotation. These two mounting surfaces as well as the standard AGR rotary stage features are shown in Figure 1-2.

The AGR series of rotary stages are available with one of Aerotech's high performance brushless servo motors mounted with motor cabling oriented as shown in Figure 1-2. Coupling access is provided allowing for easy maintenance.

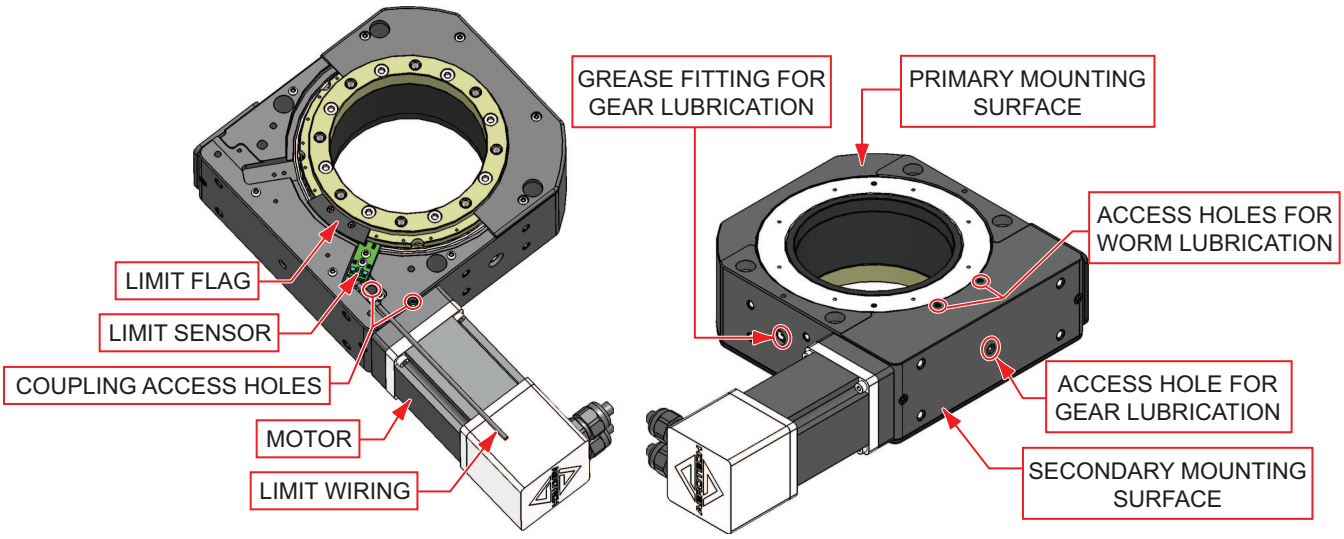


Figure 1-2: AGR Rotary Stage Showing Standard Features

A precision ground worm shaft with matching gear makes up the drive mechanism in all AGR rotary stages. The gear mesh is precisely set at the factory in such a way as to minimize wear characteristics, greatly improving stage life while maintaining stage performance even over a large temperature range. The precision ground worm drive mechanism also creates outstanding angular positioning and velocity control. This is especially useful in scanning applications where torque ripple cannot be tolerated. Other added benefits of the worm drive are high levels of torque output and natural braking ability.

The drive mechanism is lubricated with a high quality grease containing extreme pressure and anti-wear additives instead of the messy oil lube used traditionally. Designed around this grease, the AGR series of rotary stages does not require oil seals, eliminating the high levels of friction generated torque. This increases available torque for the application and reduces the required motor size. Lubrication is easily maintained on the fly with access ports on the side of the rotary table. Refer to Chapter 4: Maintenance for maintenance schedules and procedures.

The rotary stage shaft is supported by a pair of precision-ground angular contact bearings which are preloaded to ensure superior stiffness, load carrying capacity and minimal tilt errors. Stages in the AGR product family are designed to handle significant axial, radial, and moment loads. The combination of quality gear components and angular contact bearing set provide superior stage accuracy and repeatability.

Other standard design features include the optical home limit switch through a 9 pin connector. The home limit switch wiring passes through the top cover plate on the motor side and into the connector where it is then attached to the motor wiring. Refer to Section 3.5.1. for a description of home limit switch operation and wiring. The electrical wiring from the motor and encoder to the connectorized ports on the motor case is contained within the rear motor housing and has been completed at the factory. The motor cables and limit cable convey motor power, encoder feedback, and home limit switch signals to an appropriate hardware device (e.g. axis controller or amplifier). Refer to Section 3.4. for standard motor wiring and connector pin outputs.

1.2. Optional Features

1.2.1. Limited Travel Option

AGR rotary stages are available in limited travel models. The travel range of these models is between 15° and 270° in 15° increments. Each option is proved with 4° of over-travel as standard. Custom travels are handled as part of Aerotech's engineering specificaion (ES) system.

The limit output can be selected to be either normally open or normally closed.

Limit wiring can be provided with either a 9-pin “D” connector or flying leads.

1.2.2. Motor Options

Several motor offerings for the AGR series of rotary stages are available: Brushless/Slotless, Brushless, and Stepper. The AGR series is also available without an attached motor. The required motor frame size per product model is shown in Section 3.2.

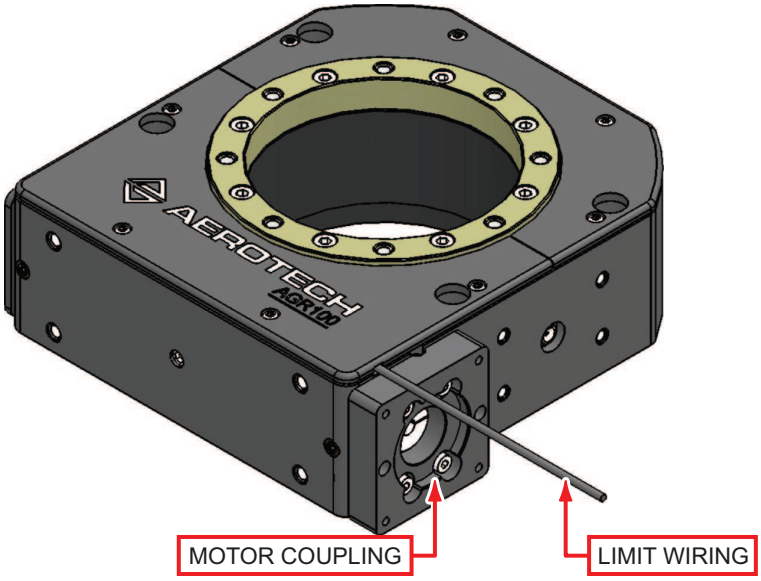


Figure 1-3: AGR Rotary Stage Without Motor Option

1.2.2.1. Motor Orientation and Location

In an effort to provide the maximum flexibility to integrate the stage into higher level systems, the motor may be mounted to the rotary stage in multiple orientations and locations. Refer to the Aerotech's online catalog for images of the motor orientation options (-R-3 is the standard combination)

In addition, the AGR series are designed such the motor can be mounted on either side of the drive mechanism, as shown in Figure 1-4.

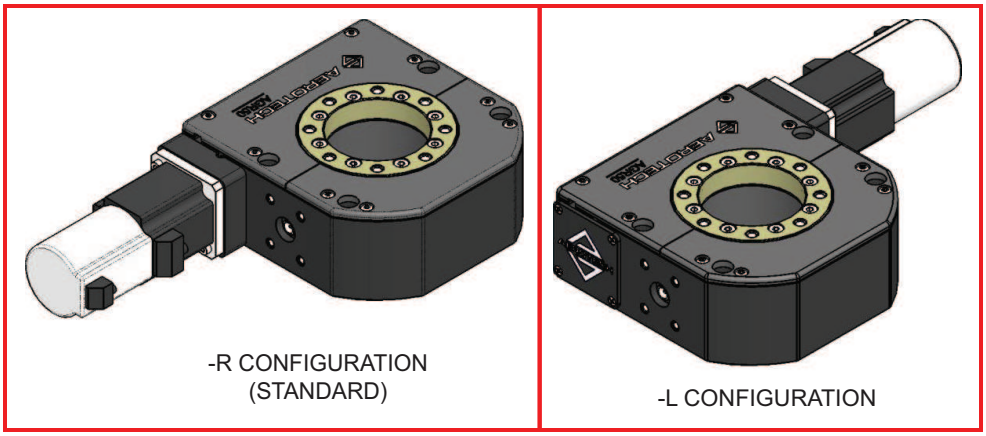


Figure 1-4: AGR Rotary Stage Motor Locations

1.2.3. Brake Option

AGR rotary stages are available with brakes integrated into the motor. Note that in two models (AGR100 and AGR150), the brake housing extends below the stage mounting surface. In addition, the stepper motor option for the AGR200 also extends below the mounting surface. Refer to the dimension drawings for specific stage details (refer to Section 1.4.). The standard AGR mounting plate option (-MP) is recommended in these cases to provide the necessary clearance for mounting the stages.

1.2.4. Encoder Option

The AGR series of rotary stages are available with direct encoders to increase stage performance. The high-performance rotary encoder is directly coupled to the payload mounting surface. This option is available in an amplified sine or with 50X TTL output. This option increases the height of the standard model (refer to Section 1.4.).

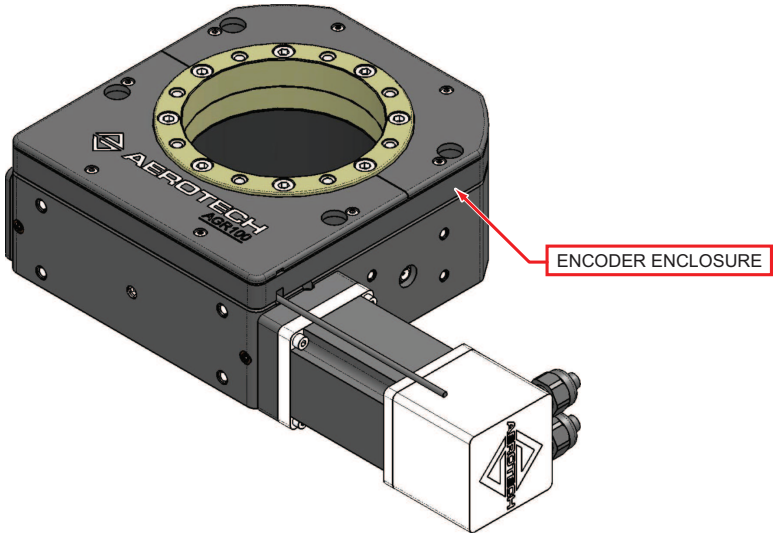


Figure 1-5: AGR Rotary Stage Encoder Option

1.2.5. Seal Option

Non-contact labyrinth seals are available in all sizes of the AGR series, as shown in Figure 1-6. This option provides protection from external contaminants while not adding any torque reducing friction. This option increases the height of the product (refer to Section 1.4.).

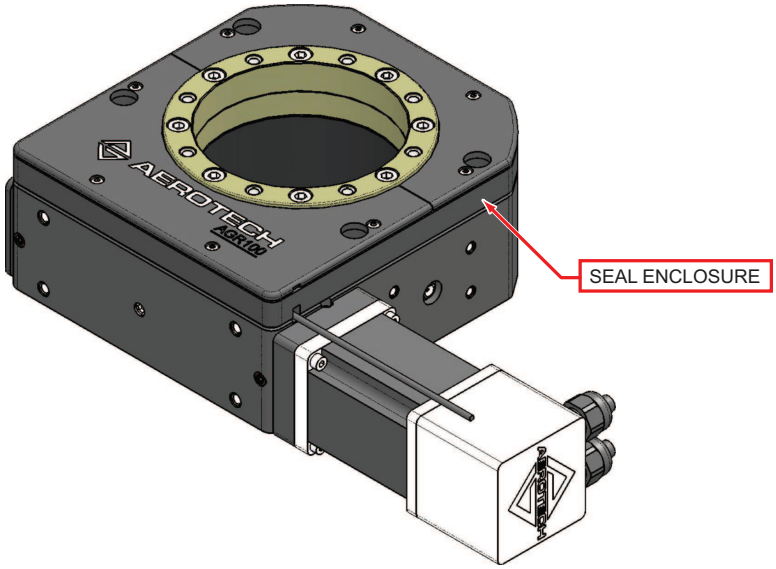


Figure 1-6: AGR Rotary Stage Seal Option

1.2.6. Accessories

Two accessories are available for the AGR series of rotary stages: English/Metric table tops and a breadboard adapter plate. An AGR100 model with both accessories is shown in Figure 1-7. The table top provides a convenient mounting pattern with both English and metric holes. The adapter plate allows the AGR series to mount to English or metric breadboards. These accessories increase the height of the product (refer to Section 1.4.).

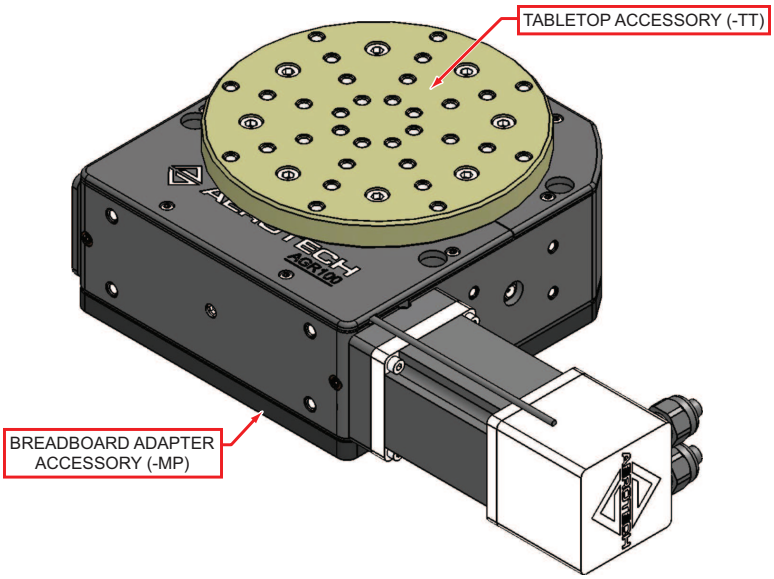


Figure 1-7: AGR Rotary Stage Accessories

1.3. Model Numbers

NOTE: Aerotech continually improves its product offerings; listed options may be superseded at any time. Refer to the most recent edition of the Aerotech Motion Control Product Guide for the most current product information at www.aerotech.com.

Table 1-1: Model Numbering System

Aperture Size	
50	50 mm diameter clear aperture
75	75 mm diameter clear aperture
100	100 mm diameter clear aperture
150	150 mm diameter clear aperture
200	200 mm diameter clear aperture
Travel Options	
-LIxx	XXX degrees of nominal limit travel (plus 2 degrees of overtravel per side) where XXX = 015 to 270 in 15 deg increments and 315 degrees
Limits Options	
-NC-9DU	Normally-closed end of travel limit switches with 9-pin connector
-NO-9DU	Normally-open end of travel limit switches with 9-pin connector
-NC-FLY	Normally-closed end of travel limit switches with flying leads
-NO-FLY	Normally-open end of travel limit switches with flying leads
Motor and Brake Options	
-NM	No motor
-SM	Stepping motor **AGR50/75**: NEMA17 stepping motor **AGR100/150**: 50SMB2-HM **AGR200**: 310SMB3-HM
-BMS	Brushless, slotless servomotor with connectors and TTL encoder (requires motor-to-controller cable) **AGR50/75**: BMS35-A-D25-E2000H **AGR100/150**: BMS60-A-D25-E2500H **AGR200**: BMS280-AH-MS-E1000H
-BMS-BK	Brushless, slotless servomotor with connectors, TTL encoder, and fail-safe brake (requires motor-to-controller cable) **AGR50/75**: BMS35-A-D25-E2000H-BK **AGR100/150**: BMS60-A-D25-E2500H-BK1 **AGR200**: BMS280-AH-MS-E1000H-BK2
-BM	Brushless servomotor with connectors and TTL encoder (requires motor-to-controller cable) **AGR50/75**: BM22-D25-E2000H **AGR100/150**: BM75-D25-E2500H **AGR200**: BM250-MS-E1000H

Motor and Brake Options (Continued)	
-BM-BK	Brushless servomotor with connectors, TTL encoder, and fail-safe brake (requires motor-to-controller cable) **AGR50/75**: BM22-D25-E2000H-BK **AGR100/150**: BM75-D25-E2500H-BK1 **AGR200**: BM250-MS-E1000H-BK2)
-BMS-AS	Brushless, slotless servomotor with 1000-line amplified sine encoder **AGR50/75**: BMS35-A-D25-E1000ASH **AGR100/150**: BMS60-A-D25-E1000ASH **AGR200**: BMS280-AH-MS-E1000ASH
-BMS-AS-BK	Brushless, slotless servomotor with fail-safe brake and 1000-line amplified sine encoder **AGR50/75**: BMS35-A-D25-E1000ASH-BK **AGR100/150**: BMS60-A-D25-E1000ASH-BK1 **AGR200**: BMS280-AH-MS-E1000ASH-BK2
-BM-AS	Brushless servomotor with 1000-line amplified sine encoder **AGR50/75**: option not available **AGR100/150**: BM75-D25-E1000ASH **AGR200**: BM250-MS-E1000ASH
-BM-AS-BK	Brushless servomotor with fail-safe brake and 1000-line amplified sine encoder **AGR50/75**: option not available **AGR100/150**: BM75-D25-E1000ASH-BK1 **AGR200**: BM250-MS-E1000ASH-BK2
Motor Location	
-R	Motor located on right side of stage housing (standard)
-L	Motor located on left side of stage housing (optional)
Motor Orientation	
-0	No motor
-2	Bottom cable exit
-3	Left side cable exit (Standard)
-4	Top cable exit
-5	Right side cable exit
Sealing Option	
-SL	Labyrinth seals supplied with product
Encoder Option	
-AS	Amplfied sine output encoder (see Table 3-3 for fundamental resolution)
-X5	Square wave TTL output; X5 multiplication
-X50	Square wave TTL output; X50 multiplication
Accessories	
-TTM	Metric tabletop
-TTU	English tabletop
-MP	Universal English/Metric mounting plate
Metrology	
-PLOTS	Accuracy and repeatability performance plots

1.4. Dimensions

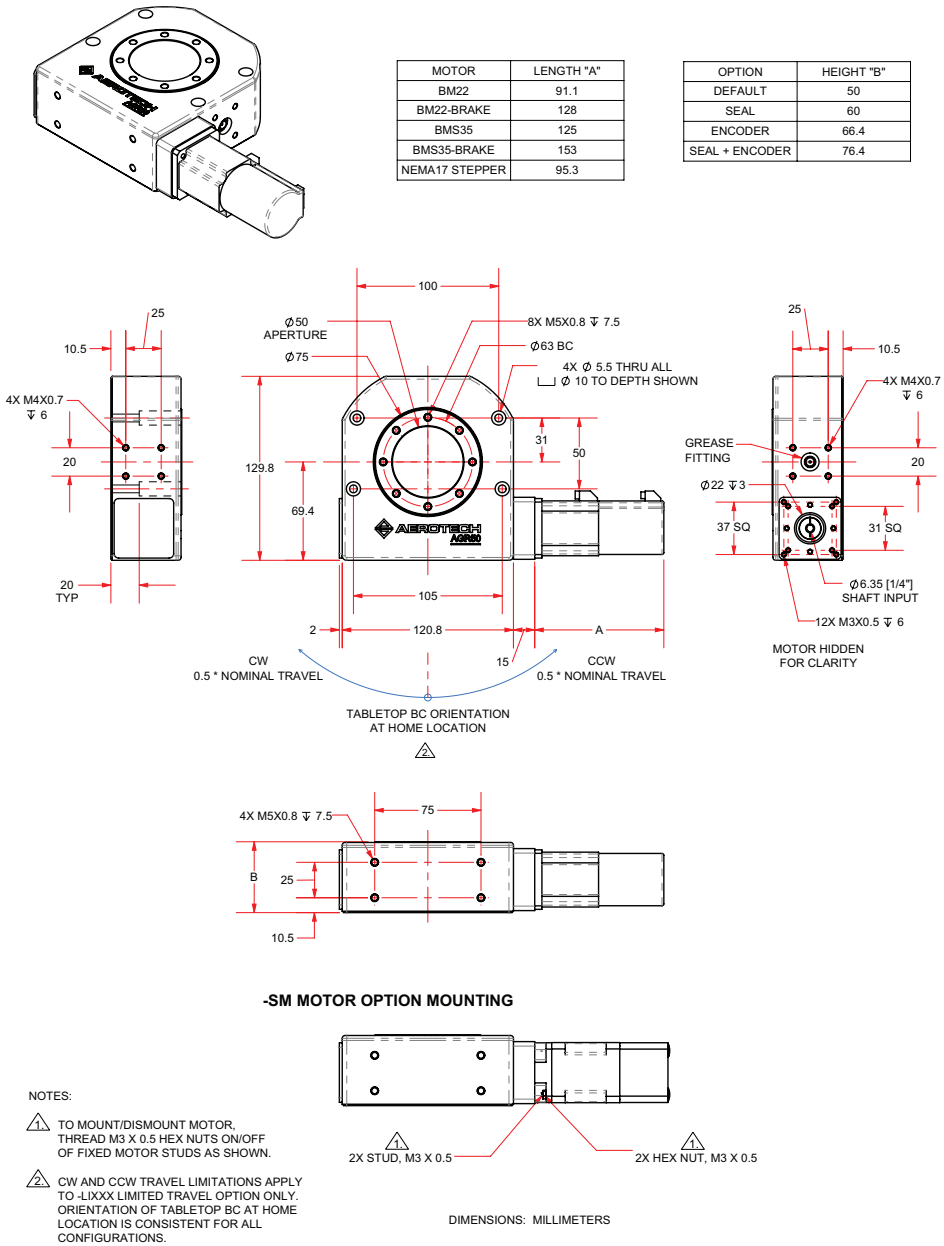
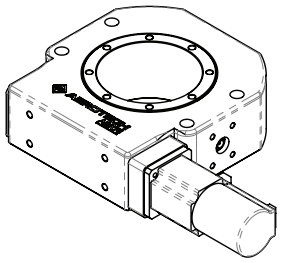
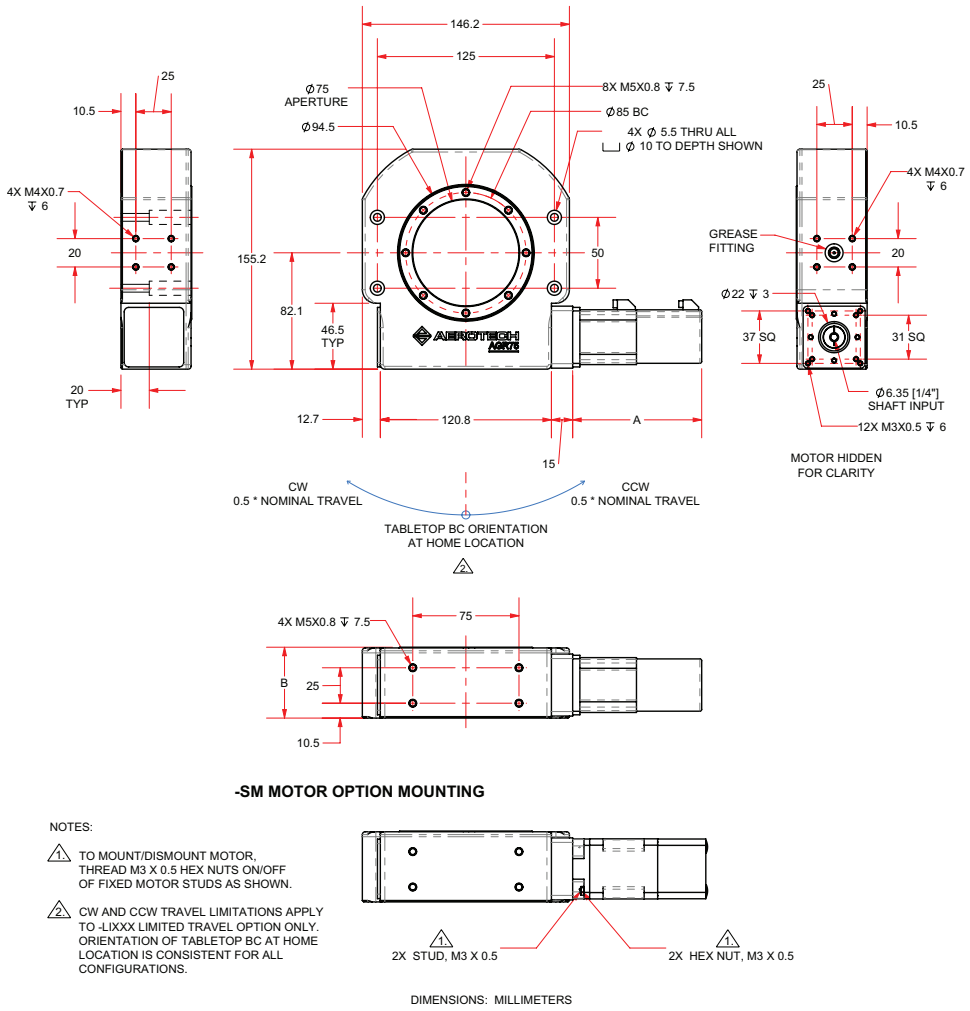


Figure 1-8: AGR50 Dimensions



MOTOR	LENGTH "A"
BM22	91.1
BM22-BRAKE	128
BMS35	125
BMS35-BRAKE	153
NEMA17 STEPPER	95.3

OPTION	HEIGHT "B"
DEFAULT	50
SEAL	60
ENCODER	66.4
SEAL + ENCODER	76.4



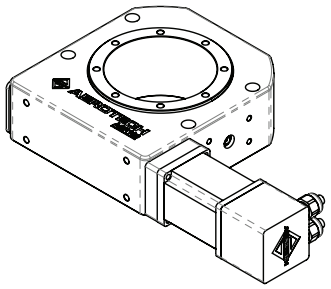
-SM MOTOR OPTION MOUNTING

NOTES:

1. TO MOUNT/DISMOUNT MOTOR, THREAD M3 X 0.5 HEX NUTS ON/OFF OF FIXED MOTOR STUDS AS SHOWN.
2. CW AND CCW TRAVEL LIMITATIONS APPLY TO -LIXXX LIMITED TRAVEL OPTION ONLY. ORIENTATION OF TABLETOP BC AT HOME LOCATION IS CONSISTENT FOR ALL CONFIGURATIONS.

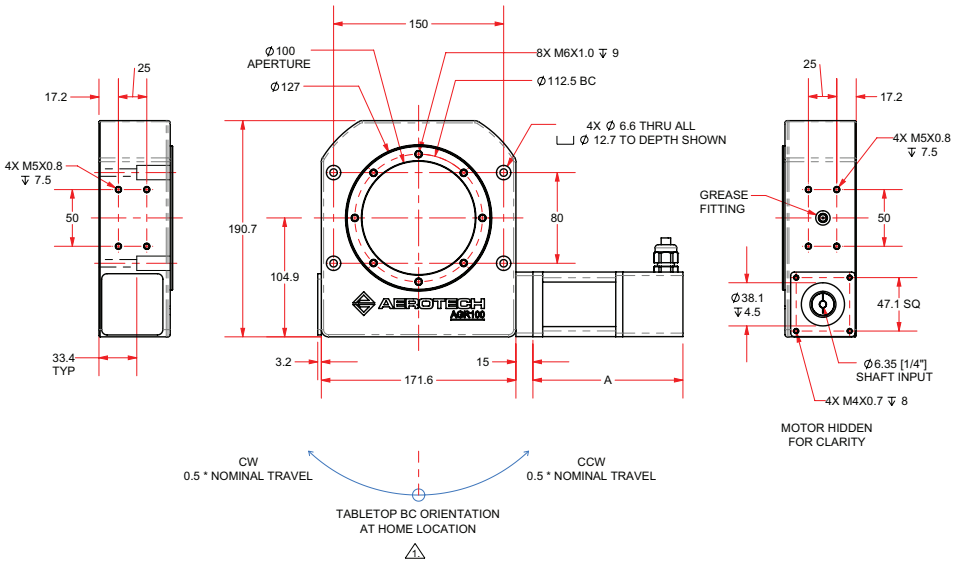
DIMENSIONS: MILLIMETERS

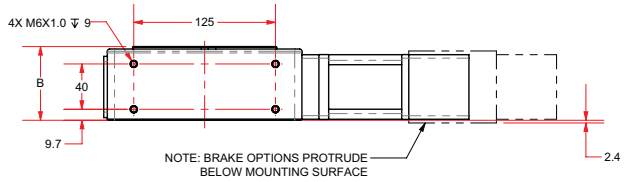
Figure 1-9: AGR75 Dimensions



MOTOR	LENGTH "A"
BM75	132.3
BM75-BRAKE	209.5
BMS60	132.3
BMS60-BRAKE	209.5
50SMB2-HM	84.3

OPTION	HEIGHT "B"
DEFAULT	65
SEAL	78
ENCODER	81
SEAL + ENCODER	94



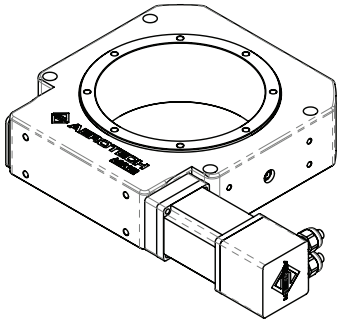


NOTES:

1. CW AND CCW TRAVEL LIMITATIONS APPLY TO -LIXXX LIMITED TRAVEL OPTION ONLY. ORIENTATION OF TABLETOP BC AT HOME LOCATION IS CONSISTENT FOR ALL CONFIGURATIONS.

DIMENSIONS: MILLIMETERS

Figure 1-10: AGR100 Dimensions



MOTOR	LENGTH "A"
BM75	132.3
BM75-BRAKE	209.5
BMS60	132.3
BMS60-BRAKE	209.5
50SMB2-HM	84.3

OPTION	HEIGHT "B"
DEFAULT	65
SEAL	78
ENCODER	81
SEAL + ENCODER	94

NOTE: CONFIGURATIONS: AGR150-SM-R-3 & AGR150-SM-L-5 ARE UNAVAILABLE AS STANDARD CONFIGURATIONS.

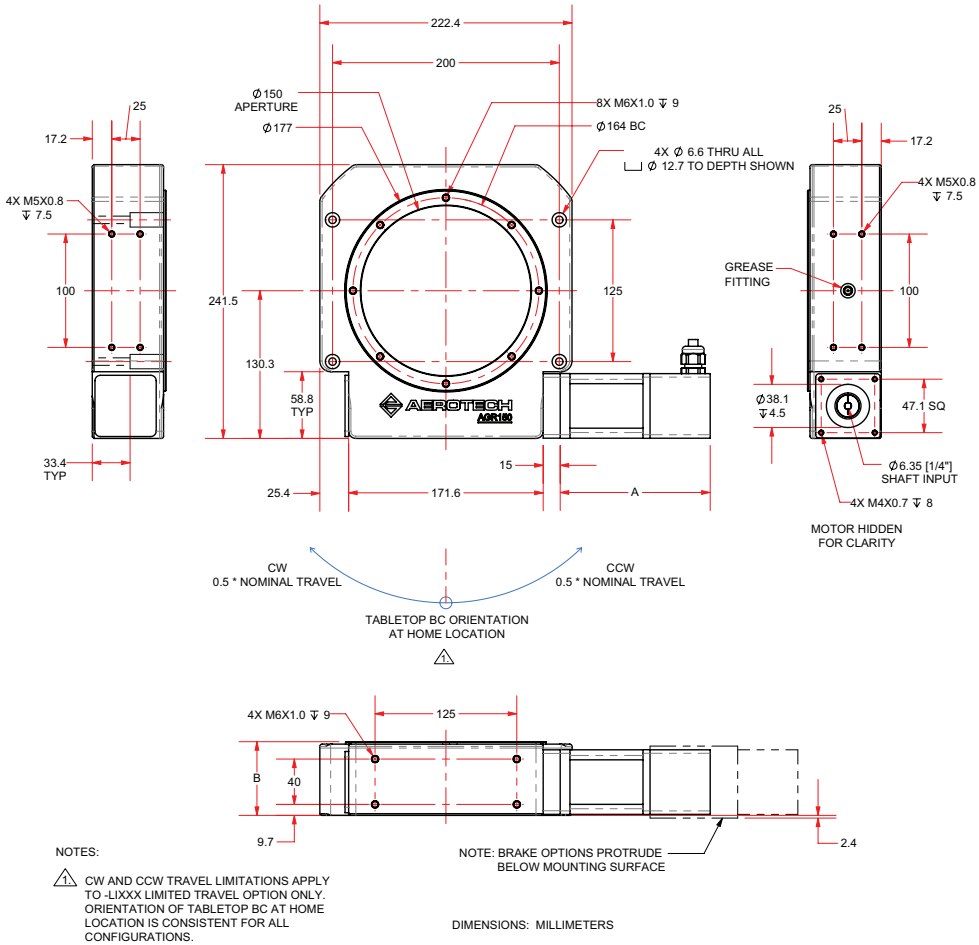
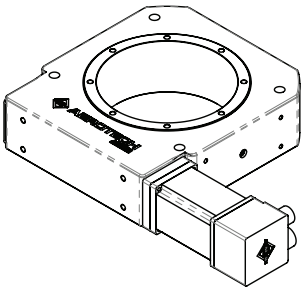


Figure 1-11: AGR150 Dimensions



MOTOR	LENGTH "A"
BM250	190
BM250-BRAKE	245.6
BMS280	190
BMS280-BRAKE	245.6
310SMB3-HM	165.4

OPTION	HEIGHT "B"
DEFAULT	90
SEAL	107
ENCODER	108.5
SEAL + ENCODER	125.5

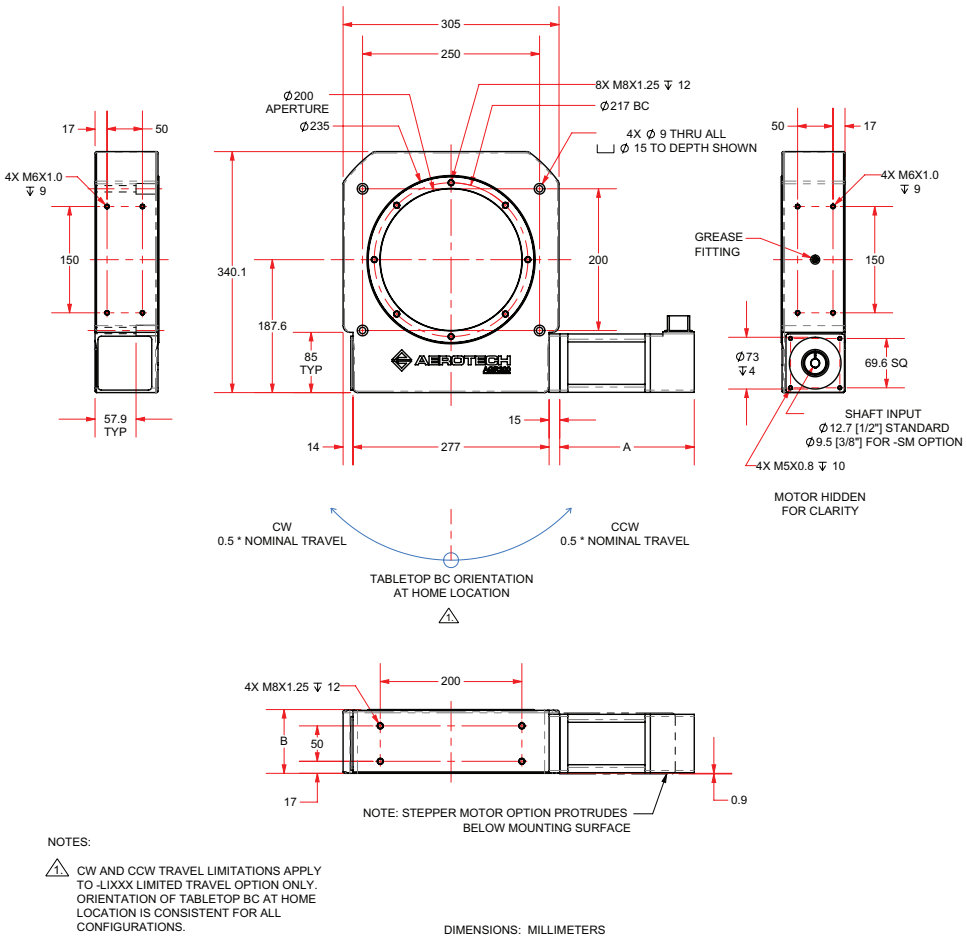


Figure 1-12: AGR200 Dimensions

1.5. Safety Procedures and Warnings

The following statements apply wherever the Warning or Danger symbol appears within this manual. Failure to observe these precautions could result in serious injury to those individuals performing the procedures and/or damage to the equipment. Operators should be trained before operating this equipment and all service and maintenance must be performed by qualified personnel.

DANGER: This product contains potentially lethal voltages. To reduce the possibility of electrical shock, bodily injury or death the following precautions must be followed.

1. Access to all AGR and component parts must be restricted while connected to a power source.
2. Do not connect or disconnect any electrical components or connecting cables while connected to a power source.
3. Disconnect electrical power before making any mechanical adjustments or performing maintenance.
4. Make sure AGR and all components are properly grounded in accordance with local electrical safety requirements.
5. Operator safeguarding requirements must be addressed during final integration of the product.

WARNING: To minimize the possibility of electrical shock, bodily injury or death the following precautions must be followed.

1. Moving parts can cause crushing or shearing injuries. Access to all stage and motor parts must be restricted while connected to a power source.
2. Cables can pose a tripping hazard. Securely mount and position all system cables to avoid potential hazards.
3. Do not expose the AGR to environments or conditions outside the specified range of operating environments. Operation in conditions other than those specified can cause damage to the equipment.
4. The AGR must be mounted securely. Improper mounting can result in injury and damage to the equipment.
5. Use care when moving the AGR. Manually lifting or transporting the AGR can result in injury.
6. This AGR is intended for light industrial manufacturing or laboratory use. Use of the AGR for unintended applications can result in injury and damage to the equipment.
7. If the AGR is used in a manner not specified by the manufacturer, the protection provided by the AGR can be impaired and result in damage, shock, injury, or death.

1.6. EC Declaration of Incorporation

Manufacturer: Aerotech, Inc.
101 Zeta Drive
Pittsburgh, PA 15238
USA

herewith declares that the product:
AGR Stage

is intended to be incorporated into machinery to constitute machinery covered by the Directive 2006/42/EC as amended;

does therefore not in every respect comply with the provisions of this directive;

and that the following harmonized European standards have been applied:
EN ISO 12100
Safety of machinery - Basic concepts, general principles for design
EN 60204-1
Safety of machinery - Electrical equipment of machines - Part 1: General requirements

and further more declares that
it is not allowed to put the equipment into service until the machinery into which it is to be incorporated or of which it is to be a component has been found and declared to be in conformity with the provisions of the Directive 2006/42/EC and with national implementing legislation, i.e. as a whole, including the equipment referred to in this Declaration.

Authorized Representative:	Manfred Besold
Address:	AEROTECH GmbH Süd-West-Park 90 D-90449 Nürnberg
Name	/ Alex Weibel
Position	Engineer Verifying Compliance
Location	Pittsburgh, PA
Date	May 14, 2013

Chapter 2: Installation

This chapter describes the installation procedure for the AGR stage, including handling the stage, preparing the mounting surface to accept the stage, securing the stage to the mounting surface, attaching the payload, and making the electrical connections.

WARNING: AGR installation must be in accordance to instructions provided by this manual and any accompanying documentation. Failure to follow these instructions could result in injury and damage to the equipment.

2.1. Unpacking and Handling the Stage

Carefully remove the AGR from the protective shipping container. Before operating the AGR, it is important to let the AGR stabilize at room temperature for at least 12 hours. Allowing the AGR to stabilize to room temperature will ensure that all of the alignments, preloads, and tolerances are the same as they were when tested at Aerotech. Use compressed nitrogen or clean, dry, oil-less air to remove any dust or debris that has collected during shipping. Set the AGR on a smooth, flat, and clean surface.

Each AGR has a label listing the system part number and serial number. These numbers contain information necessary for maintaining or updating system hardware and software. Locate this label and record the information for later reference. If any damage has occurred during shipping, report it immediately.

WARNING: Make sure all moving parts are secure before moving the AGR. Unsecured moving parts may shift and cause bodily injury.

WARNING: Lift the AGR only by the base. Improper handling could adversely affect the AGR's performance.

2.2. Preparing the Mounting Surface

The mounting surface should be flat and have adequate stiffness in order to achieve the maximum performance from the AGR. When the AGR is mounted to a non-flat surface, the stage can be distorted as the mounting screws are tightened. This distortion will decrease the overall accuracy of the stage. Adjustments to the mounting surface must be done before the stage is secured.

NOTE: To maintain accuracy, the mounting surface should be flat within 10 µm over the entire stage footprint.

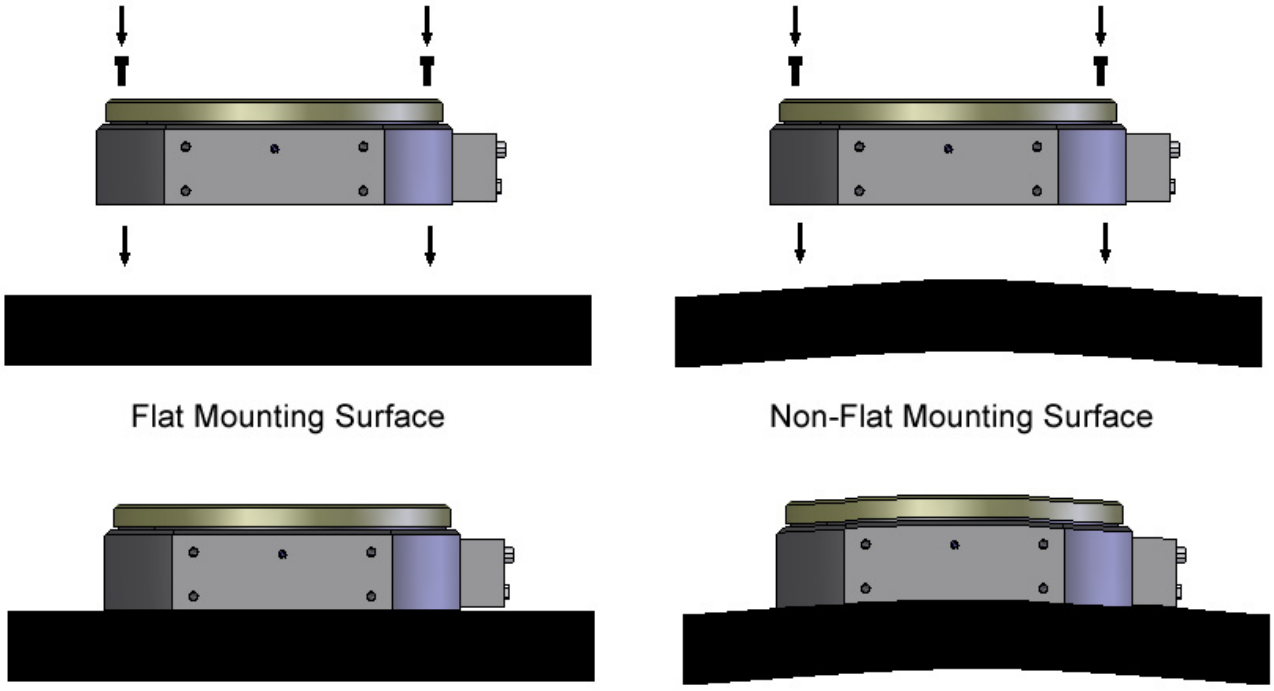


Figure 2-1: Results of Flat Versus Non-Flat Mounting

NOTE: The AGR is precision machined and verified for flatness prior to product assembly at the factory. If machining is required to achieve the desired flatness, it should be performed on the mounting surface rather than the AGR . Shimming should be avoided if possible. If shimming is required, it should be minimized to improve the rigidity of the system.

2.3. Securing the Stage to the Mounting Surface

AGR series stages have a fixed mounting pattern available to secure the stage to a mounting surface. The counter-bored mounting holes are designed for 5 mm socket head cap screws (SHCS) for the AGR50 and AGR75, 6 mm SHCS for the AGR100 and AGR150, and 8 mm SHCS for the AGR200.

WARNING: The AGR must be mounted securely. Improper mounting can result in injury and damage to the equipment.

AGR series stages also have a fixed mounting pattern on the side of the stage. The size of the side mounting holes are M5 for the AGR50 and AGR75; M6 for the AGR100 and AGR150; and M8 for the AGR200.

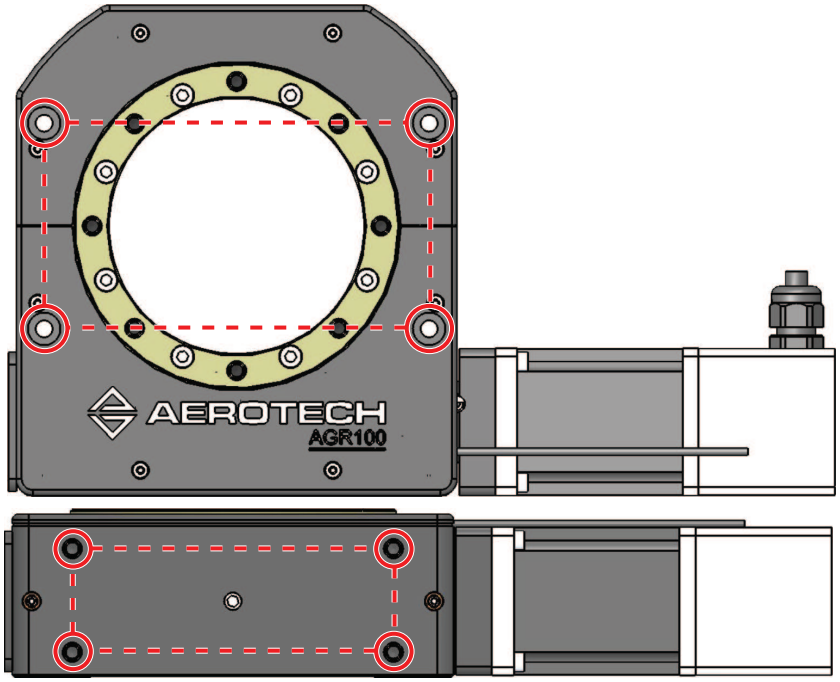


Figure 2-2: View of an AGR Stage Showing Mounting Holes

2.4. Motor Installation

The basic model of the AGR series of rotary stages are factory shipped with the appropriate sized motor. When the “no motor” option has been selected or for motor service, access to the motor coupling is provided by removing half of the split top cover that is directly above the rotary motor (refer to Figure 1-2 for locations of the coupling access holes).

2.5. Attaching the Payload to the Stage

To prevent damage to payloads, test the operation of the stage before the payload is attached to the stage table. Proceed with the electrical installation and test the motion control system in accordance with the system documentation. Document all results for future reference. For information on electrical connections, refer to Section 3.4. and the documentation delivered with the stage.

The payload must be flat, rigid, and comparable to the stage in quality.

2.6. Electrical Installation

WARNING: Electrical installation must be performed by properly qualified personnel.

Aerotech motion control systems are adjusted at the factory for optimum performance. When the AGR is part of a complete Aerotech motion control system, setup usually involves connecting a stage and motor combination to the appropriate drive chassis with the cables provided. Connect the provided cables to the feedback and motor connectors on the stage body. Labels on the system components usually indicate the appropriate connections.

Refer to the appropriate system manuals and documentation included on the CD-ROM for additional installation and operation information. If the system is uniquely configured, a drawing showing system interconnects is supplied.

WARNING: Applications requiring access to the stage while it is energized will require additional grounding and safeguards. The System Integrator or qualified installer is responsible for determining and meeting all safety and compliance requirements necessary for the integration of this stage into the final application.

DANGER: Remove power before connecting or disconnecting electrical components or cables. Failure to do so may cause electric shock.

WARNING: Operator access to the base and table top must be restricted while connected to a power source. Failure to do so may cause electric shock.

NOTE: Refer to the controller documentation to adjust servo gains for optimum velocity and position stability.

Chapter 3: Operating Specifications

The surrounding environment and operating conditions can affect the performance and service life of the stage. This chapter provides information on ideal environmental and operating conditions.

3.1. Environmental Specifications

The environmental specifications for the AGR are listed in the following table.

Table 3-1: Environmental Specifications

Ambient Temperature	Operating: 10° to 35° C (50° to 95° F) The optimal operating temperature is 20° C ±2° C (68° F ±4° F). If at any time the operating temperature deviates from 20° C degradation in performance could occur. Contact Aerotech for information regarding your specific application and environment.
	Storage: 0° to 40° C (32° to 104° F) in original shipping packaging
Humidity	Operating: 20% to 60% RH
	Storage: 10% to 70% RH, non-condensing in original packaging
Altitude	Operating: 0 m to 2,000 m (0 ft to 6,562 ft) above sea level Contact Aerotech if your specific application involves use above 2,000 m or below sea level.
Vibration	Use the system in a low vibration environment. Excessive floor or acoustical vibration can affect system performance. Contact Aerotech for information regarding your specific application.
Dust Exposure	In their standard configuration the AGR stages have limited protection against airborne particles but not water. This equates to an ingress protection rating of IP40. With the Seal (-SL) option the AGR stages have limited protection against dust, but no protection against water. This equates to an ingress protection rating of IP50.
Use	Indoor use only

WARNING: Do not expose the AGR to environments or conditions outside the specified range of operating environments. Operation in conditions other than those specified can cause damage to the equipment.

3.2. Basic Specifications

Basic AGR series positioning stage specifications are shown below.

Table 3-2: AGR Series Mechanical Specifications

		AGR50	AGR75	AGR100	AGR150	AGR200
Travel		360° (Limited Travel Versions Available)				
Frame Size		NEMA17	NEMA17	NEMA23	NEMA23	NEMA34
Accuracy	Standard	180 arc sec	180 arc sec	120 arc sec	120 arc sec	120 arc sec
	Direct Encoder	20 arc sec				
Repeatability (Unidirectional) (1)	Standard	10 arc sec				
	Direct Encoder	5 arc sec				
Repeatability (Bi-Directional) (1)	Standard	45 arc sec				
	Direct Encoder	8 arc sec				
Tilt Error Motion		10 arc sec				
Axial Error Motion		5 µm				
Radial Error Motion		10 µm				
Gear Ratio		51:1	67:1	85:1	117:1	126:1
Maximum Speed (2)	BM/BMS	180°/s	180°/s	180°/s	180°/s	120°/s
	SM	60°/s	60°/s	40°/s	40°/s	40°/s
Maximum Acceleration (3)		720°/s^2	720°/s^2	720°/s^2	720°/s^2	480°/s^2
Aperture		50 mm	75 mm	100 mm	150 mm	200 mm
Load Capacity	Axial	40 kg	100 kg	200 kg	300 kg	425 kg
	Radial	20 kg	50 kg	100 kg	125 kg	200 kg
	Moment	See Moment Load Capacity: Section 3.3.				
Maximum Torque Load to Stage Shaft		2.5 N·m	3.5 N·m	12 N·m	20 N·m	80 N·m
Rotor Inertia (Unloaded)		0.00052 kg-·m^2	0.0013 kg-·m^2	0.0035 kg-m^2	0.011 kg-m^2	0.076 kg-m^2
Stage Mass (No Motor)	Standard	1.9 kg	2.4 kg	4.5 kg	6.1 kg	18.6 kg
	Direct Encoder	2.5 kg	3.1 kg	5.6 kg	7.6 kg	21.7 kg
Material		Aluminum				

1. Certified with each stage.
2. Maximum speed is load dependent. Contact an Aerotech Application Engineer if imbalanced loads are present.
3. Unloaded acceleration
4. On-axis loading is listed
5. Specifications are for single-axis systems, measured 25 mm above the tabletop. Performance of multi-axis system is payload and workpoint dependent. Consult factory for multi-axis or non-standard applications.

Table 3-3: Electrical Specifications

Model		AGR50	AGR75	AGR100	AGR150	AGR200
Drive System		Precision Worm-Gear with Brushless or Stepping Motor				
Feedback	Standard	Rotary Motor Feedback: 2000 Lines/Rev Square Wave (BM Motor); 2500 Lines/Rev Square Wave and 1000 Lines/Rev Amplified Sine (BMS Motor)		Rotary Motor Feedback: 2500 Lines/Rev Square Wave and 1000 Lines/Rev Amplified Sine		
	Direct Encoder	Noncontact Rotary Encoder Directly Mounted to AGR Stage Shaft				
		15744 Lines/Rev	18000 Lines/Rev	23600 Lines/Rev	31488 Lines/Rev	40000 Lines/Rev
Maximum Bus Voltage		80 VDC (BM Motor); 320 VDC (BMS Motor)		320 VDC		
Limit Switches		5 V, Normally Closed or Normally Open				
Home Switch		Near Limit (for Limited Travel Stage Version)				

WARNING: The motor case temperature may exceed 75ºC.

Table 3-4: Recommended Controller

Multi-Axis	A3200	Ndrive MP10 / Ndrive CP10 / Npaq
	Ensemble	Ensemble MP10 / Ensemble CP10 / Epaq
Single Axis	Soloist	Soloist MP10 / Soloist CP10

Table 3-5: BMS35 and BMS60 Motor Specifications (AGR50/75 - BMS35, AGR100/150 - BMS60)

Motor Model	Units	BMS35	BMS60
Winding Designation		-A	-A
Performance Specifications (1, 5)			
Stall Torque, Continuous (2)	N·m (oz·in)	0.27 (38.0)	0.33 (46.2)
Peak Torque (3)	N·m (oz·in)	1.07 (152.0)	1.31 (184.9)
Rated Speed	rpm	4,000	4,000
Rated Power Output, Continuous	W	96	112
Electrical Specifications (5)			
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	12.9	19
Continuous Current, Stall (2)	A_{pk} (A_{rms})	2.5 (1.7)	2.3 (1.6)
Peak Current, Stall (3)	A_{pk} (A_{rms})	9.8 (6.9)	9.2 (6.5)
Torque Constant (4, 8)	N·m/A_{pk} (oz·in/A_{pk})	0.11 (15.5)	0.14 (20.1)
	N·m/A_{rms} (oz·in/A_{rms})	0.15 (21.9)	0.20 (28.4)
Motor Constant (2, 4)	N·m/√W (oz·in/√W)	0.046 (6.52)	0.050 (7.02)
Resistance, 25°C (Line-Line)	Ω	5.8	8.4
Inductance (Line-Line)	mH	1.7	1.30
Maximum Bus Voltage	V_{DC}	340	340
Thermal Resistance	°C/W	2.21	1.73
Number of Poles	--	8	8
Mechanical Specifications			
Motor Weight	kg (lb)	0.6 (1.3)	1.1 (2.4)
Rotor Moment of Inertia	kg·m^2 (oz·in·s^2)	$1.96x10^{-5}$ (0.0028)	$1.96x10^{-5}$ (0.0028)
Max Radial Load	N (lb)	45 (10)	89 (20)
Max Axial Load	N (lb)	45 (10)	89 (20)
Frame Size	NEMA	17	23

(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
(2) Values shown @ 75°C rise above a 25 °C ambient temperature, with motor mounted to the specified aluminum heat sink
(3) Peak force assumes correct rms current; consult Aerotech.
(4) Force constant and motor constant specified at stall.
(5) All performance and electrical specifications +/- 10%
(6) Maximum winding temperature is 100 °C (Thermistor trips at 100°C)
(7) Ambient operating temperature range: 0 °C - 25 °C, consult Aerotech for performance in elevated ambient temperatures
(8) All Aerotech amplifiers are rated A_{pk}; use force constant in N / A_{pk} when sizing

WARNING: The motor case temperature may exceed 75ºC.

Table 3-6: BMS280 Motor Specifications (AGR200)

Motor Model	Units	BMS280
Winding Designation		-A
Performance Specifications (1, 5)		
Stall Torque, Continuous (2)	N·m (oz·in)	1.60 (227.0)
Peak Torque (3)	N·m (oz·in)	6.41 (908.0)
Rated Speed	rpm	3,000
Rated Power Output, Continuous	W	381
Electrical Specifications (5)		
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	57
Continuous Current, Stall (2)	A_{pk} (A_{rms})	3.8 (2.7)
Peak Current, Stall (3)	A_{pk} (A_{rms})	15.2 (10.7)
Torque Constant (4, 8)	N·m/A_{pk} (oz·in/A_{pk})	0.42 (59.7)
	N·m/A_{rms} (oz·in/A_{rms})	0.60 (84.5)
Motor Constant (2, 4)	N·m/√W (oz·in/√W)	0.179 (25.34)
Resistance, 25°C (Line-Line)	Ω	5.7
Inductance (Line-Line)	mH	1.10
Maximum Bus Voltage	V_{DC}	340
Thermal Resistance	°C/W	0.93
Number of Poles	--	14
Mechanical Specifications		
Motor Weight	kg (lb)	3.60 (7.9)
Rotor Moment of Inertia	kg·m^2 (oz·in·s^2)	$4.66x10^{-4}$ (0.0660)
Max Radial Load	N (lb)	178 (40)
Max Axial Load	N (lb)	89 (20)
Frame Size	NEMA	34

(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
(2) Values shown @ 75°C rise above a 25 °C ambient temperature, with motor mounted to the specified aluminum heat sink
(3) Peak force assumes correct rms current; consult Aerotech.
(4) Force constant and motor constant specified at stall.
(5) All performance and electrical specifications +/- 10%
(6) Maximum winding temperature is 100 °C (Thermistor trips at 100°C)
(7) Ambient operating temperature range: 0 °C - 25 °C, consult Aerotech for performance in elevated ambient temperatures
(8) All Aerotech amplifiers are rated Apk; use force constant in N / Apk when sizing

WARNING: The motor case temperature may exceed 75ºC.

Table 3-7: BM22 and BM75 Motor Specifications (AGR50/75 - BM22, AGR100/150 - BM75)

Motor Model	Units	BM22	BM75
Performance Specifications (1,5)			
Stall Torque, Continuous (2,8)	N·m (oz·in)	0.16 (22.5)	0.55 (78.3)
Peak Torque(3)	N·m (oz·in)	0.48 (68.0)	1.4 (196)
Rated Speed	rpm	3,000	4,000
Rated Power Output, Continuous	W	50	207
Electrical Specifications(5)			
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	3.9	9
Continuous Current, Stall (2,8)	A_{pk} (A_{rms})	4.9 (3.5)	10.0 (7.1)
Peak Current, Stall (3)	A_{pk} (A_{rms})	14.7 (10.4)	25.0 (17.7)
Torque Constant (4,9)	N·m/A_{pk} (oz·in/A_{pk})	0.032 (4.5)	0.06 (7.8)
	N·m/(A_{rms} (oz·in/(A_{rms})	0.045 (6.4)	0.08 (11.1)
Motor Constant (2,4)	N·m/√W (oz·in/√W)	0.038 (5.37)	0.052 (7.33)
Resistance, 25°C (Line-Line)	Ω	0.67	1.0
Inductance (Line-Line)	mH	0.73	0.80
Maximum Bus Voltage	V_{DC}	80	340
Thermal Resistance	°C/W	6.26	1.14
Number of Poles	--	8	8
Mechanical Specifications			
Motor Weight	kg (lb)	0.4 (0.88)	1.1 (2.42)
Rotor Moment of Inertia	kg·m^2 (oz·in·s^2)	$2.00x10^{-6}$ (0.00028)	$5.20x10^{-6}$ (0.0007)
Max Radial Load	N (lb)	78 (18)	89 (20)
Max Axial Load	N (lb)	39 (9)	89 (20)
Frame Size	NEMA	17	23

(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
(2) Values shown @ 130°C rise above a 25 °C ambient temperature, with motor mounted to the specified aluminum heat sink
(3) Peak force assumes correct rms current; consult Aerotech.
(4) Force constant and motor constant specified at stall.
(5) All performance and electrical specifications +/- 10%
(6) Maximum winding temperature is 155 °C
(7) Ambient operating temperature range: 0 °C - 25 °C, consult Aerotech for performance in elevated ambient temperatures
(8) De-rate continuous torque and continuous current by 10 percent when using an encoder
(9) All Aerotech amplifiers are rated Apk; use force constant in N / Apk when sizing

WARNING: The motor case temperature may exceed 75ºC.

Table 3-8: BM250 Motor Specifications (AGR200)

Motor Model	Units	BM250
Performance Specifications (1,5)		
Stall Torque, Continuous(2,8)	N·m (oz·in)	2.0 (285)
Peak Torque (3)	N·m (oz·in)	5.0 (712)
Rated Speed	rpm	4,000
Rated Power Output, Continuous	W	671
Electrical Specifications (5)		
BEMF Constant (Line-Line, Max)	V_{pk}/k_{rpm}	28
Continuous Current, Stall (2,8)	A_{pk} (A_{rms})	10.5 (7.4)
Peak Current, Stall (3)	A_{pk} (A_{rms})	26.3 (18.6)
Torque Constant (4,9)	N·m/A_{pk} (oz·in/A_{pk})	0.19 (27.1)
	N·m/A_{rms} (oz·in/A_{rms})	0.27 (38.4)
Motor Constant (2,4)	N·m/√W (oz·in/√W)	0.171 (24.24)
Resistance, 25°C (Line-Line)	Ω	1.1
Inductance (Line-Line)	mH	1.30
Maximum Bus Voltage	V_{DC}	340
Thermal Resistance	°C/W	0.94
Number of Poles	--	8
Mechanical Specifications		
Motor Weight	kg (lb)	3.6 (7.92)
Rotor Moment of Inertia	kg·m^2 (oz·in·s^2)	$7.85x10^{-5}$ (0.0111)
Max Radial Load	N (lb)	178 (40)
Max Axial Load	N (lb)	89 (20)
Frame Size	NEMA	34

(1) Performance is dependent upon heat sink configuration, system cooling conditions, and ambient temperature
(2) Values shown @ 130°C rise above a 25 °C ambient temperature, with motor mounted to the specified aluminum heat sink
(3) Peak force assumes correct rms current; consult Aerotech.
(4) Force constant and motor constant specified at stall.
(5) All performance and electrical specifications +/- 10%
(6) Maximum winding temperature is 155 °C
(7) Ambient operating temperature range: 0 °C - 25 °C, consult Aerotech for performance in elevated ambient temperatures
(8) De-rate continuous torque and continuous current by 10 percent when using an encoder
(9) All Aerotech amplifiers are rated Apk; use force constant in N / Apk when sizing

WARNING: The motor case temperature may exceed 75ºC.

Table 3-9: Stepper Motor Specifications (AGR50/75 - NEMA17, AGR100/150 - 50SM, AGR200 - 310SM)

Model	Units	NEMA17	50SM	310SM
NEMA Motor Frame Size		17	23	34
Stall Torque	N·m (oz·in)	0.59 (83)	0.3 (38)	2.6 (370)
Rated Phase Current	A	2.1	1	6
Recommended Driver Bus Voltage	V	40	40	80
Rotor Inertia	$kg \cdot m^2$ ($oz \cdot in \cdot s^2$)	6.80×10^{-6} (9.58×10^{-4})	12×10^{-6} (1.66×10^{-3})	187×10^{-6} (27×10^{-3})
Full Step Angle	°	1.8	1.8	1.8
Accuracy	°	0.05	±0.054° (Non-Cumulative)	±0.054° (Non-Cumulative)
Maximum Radial Load	N (lb)	26.7 (6)	67 (15)	156 (35)
Maximum Thrust Load	N (lb)	26.7 (6)	111 (25)	267 (60)
Weight	kg (lb)	0.32 (0.7)	0.6 (1.4)	3.5 (7.8)

WARNING: The motor case temperature may exceed 75ºC.

3.3. Moment Load Capacity

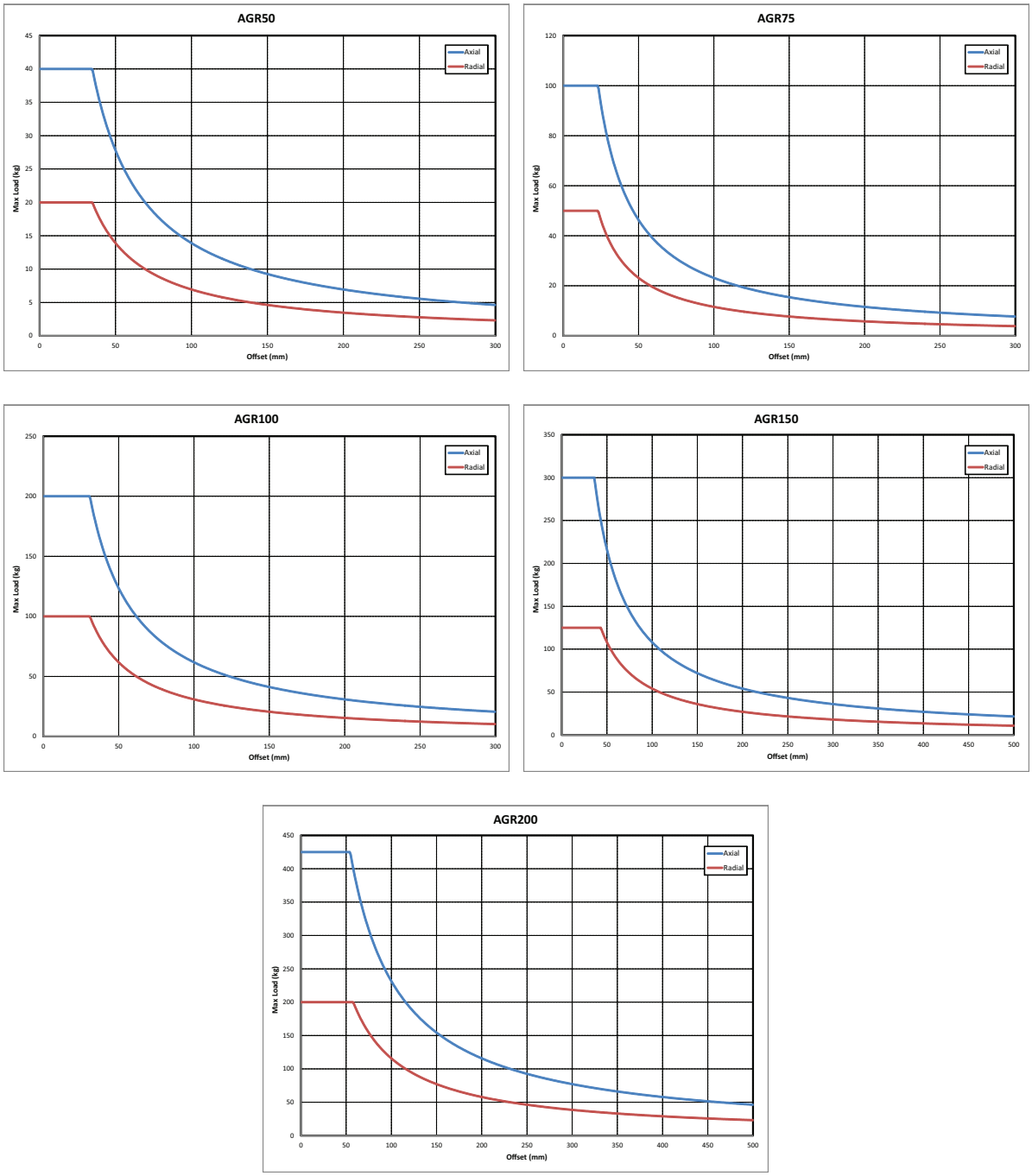


Figure 3-1: AGR Axial and Radial Cantilevered Load Capability

3.4. Standard Motor Wiring

Stages fitted with standard motors and encoders come from the factory completely wired and assembled. Connector pin assignments and general wiring information are provided for reference.

NOTE: Refer to the other documentation accompanying your Aerotech equipment. Call your Aerotech representative if there are any questions on system configuration.

NOTE: If you are using your own cables to connect the AGR and components, refer to 3.4 for wire gauge and insulation specifications. Feedback wiring must be shielded and separated from the motor wiring.

The AGR's protective ground connection provides motor frame ground protection only. Additional grounding and safety safeguards are required for applications requiring access to the stage while it is energized. The System Integrator or qualified installer is responsible for determining and meeting all safety and compliance requirements necessary for the integration of this stage into the final application.

DANGER: Remove power before connecting or disconnecting electrical components or cables. Failure to do so may cause electric shock.

WARNING: The protective ground connection must be properly installed to minimize the possibility of electric shock.

WARNING: Operator access to the base and table top must be restricted while connected to a power source. Failure to do so may cause electric shock.

CAUTION: The stage controller must provide over-current and over-speed protection. Failure to do so may result in permanent damage to the motor and stage components.

Table 3-10: High Power D-Style Motor Connector Pin Assignment

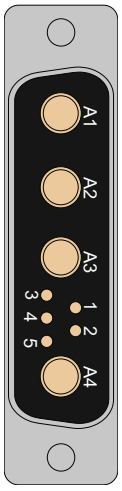
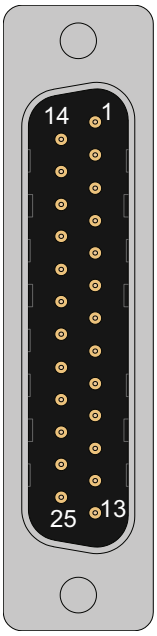
Pin	Description	Connector
A1	MTR ØA (Motor Phase A)	
A2	MTR ØB (Motor Phase B)	
A3	MTR ØC (Motor Phase C)	
1	Motor Shield (EMI shield)	
2	Reserved: Not Used	
3	Reserved: Not Used	
4	Reserved: Not Used	
5	Reserved: Not Used	
A4	Frame Ground (motor protective ground)	

Table 3-11: High Power D-Style Mating Connector

	Aerotech P/N	Third Party P/N
Backshell	ECK00656	Amphenol #17-1726-2
Sockets	ECK00659	ITT Cannon #DM53744-6
Connector	ECK00657	ITT Cannon #DBMM9W4S

Table 3-12: Motor Feedback Connector Pin Assignment (D-Style Connector)

Pin	Label	Description	Connector
1	SIG SHLD	Signal shield connection	
2	Thermistor (1)	Over-temperature Thermistor Sensor	
3	Encoder +5V	+5 V supply input for optical encoders (the typical requirement is 250 mA).	
5	HALL B	Hall Effect sensor, phase B	
6	MKR-N	Marker-N	
7	MKR	Marker	
10	HALL A	Hall Effect sensor, phase A	
11	HALL C	Hall Effect sensor, phase C	
13	Brake -(2)	Brake -	
14	COS	Cosine	
15	COS-N	Cosine-N	
17	SIN	Sine	
18	SIN-N	Sine-N	
21	Encoder Common	Common ground to encoder power	
25	Brake +(2)	Brake +	

(1) BMS motors only. Reserved on all other motors.
(2) With Brake option only

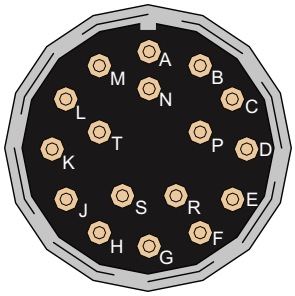
Table 3-13: Mating Connector for the Motor Feedback Connector

	Aerotech P/N	Third Party P/N
Backshell	ECK00656	Amphenol #17-1726-2
Connector	ECK00300	Cinch DB-255

3.4.1. Motor Wiring for the AGR200

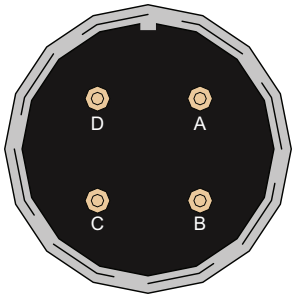
By default, the AGR200 stage comes with an attached BMS280 motor with MS connectors. The AGR200 is the only stage in the AGR series for which the BMS280 is available.

Table 3-14: Feedback Connector Pin Assignment (MS3101A20-29P)

Pin	Function	Connector
A	Cosine	
B	Cosine-N	
C	Sine	
D	Sine-N	
E	Marker	
F	Marker-N	
G	Common	
H	+5V	
J	Shield (no connection to frame)	
K	Hall Effect A	
L	Over-Temperature Thermistor Sensor (1)	
M	Hall Effect B	
N	Reserved	
P	Hall Effect C	
R	Reserved	
S	Brake + (2)	
T	Brake - (2)	

(1) BMS motors only. Reserved on all other motors.
(2) 24 VDC @ 1 A max

Table 3-15: Motor Power Connector Pin Assignment (MS3101A18-10P)

Pin	Function	Connector
A	Motor Phase A	
B	Motor Phase B	
C	Motor Phase C	
D	Motor Frame Ground	
Backshell	Motor Cable Shield	

3.4.2. Position Encoder Wiring

Stages fitted with standard motors and encoders come from the factory completely wired and assembled. Connector pin assignments and general wiring information are provided for reference.

Table 3-16: Position Encoder Connector Pin Assignment

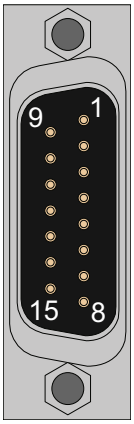
Pin #	Pin Output	Description	Connector
1	SIN	Sine. Incremental encoder output; either TTL line driven or amplified sine wave type signal.	
2	COS	Cosine. Incremental encoder output; either TTL line driven or amplified sine wave type signal.	
3	MKR	Marker. Incremental encoder output pulse produced once per travel length. Usually used for home reference cycle.	
4	+5V	+5 V supply input for optical encoders (the typical requirement is 250 mA).	
5	Reserved	Not Used	
6	Reserved	Not Used	
7	Reserved	Not Used	
8	Reserved	Not Used	
9	SIN-N	Incremental encoder output; the compliment of SIN.	
10	COS-N	Incremental encoder output; the compliment of COS	
11	MKR-N	Incremental encoder output; the compliment of Marker (MKR)	
12	COM	Common ground to encoder power	
13	Reserved	Not Used	
14	Reserved	Not Used	
15	Reserved	Not Used	

Table 3-17: Position Encoder Mating Connector

	Aerotech P/N	3rd Party P/N
Backshell	ECK00326	DA-155
Connector	ECK01022	Amphenol 17-1725-2

3.5. Limit Switch Wiring

AGR series stages are provided with a optical limit switch. The limit switch signals when the stage has reached its maximum useable travel distance in all directions. The limit switch is mounted to a small circuit board within the stage. A reflective surface is used as a trigger.

3.5.1. Limit Switch Operation

The limit switch is mounted on a small, printed circuit board. AGR stages with the limit option include a limit switch connector. Limit switches on AGR series stages can be configured as normally-open or as normally-closed. Typically, the input to the controller is seen as a logic 0 (typical 0.4V at 12.8 mA) when no limit condition is present. When the limit switch is activated, a 5V source through a pull-up resistor causes a logic 1 (typically 4.8-5V) to be seen by the controller input.

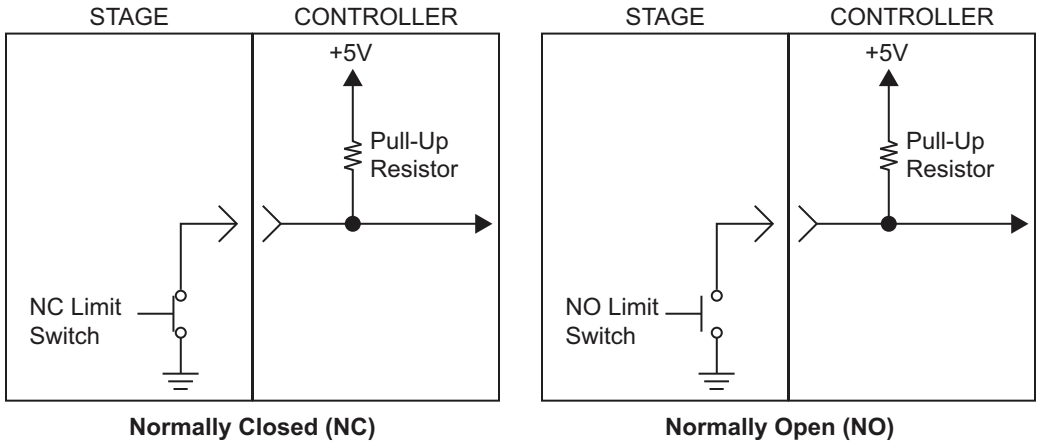


Figure 3-2: Limit Switch Wiring

Table 3-18: Limit Switch Connector Pin Assignment

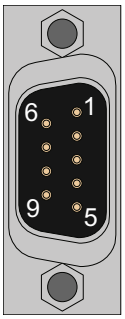
Pin #	Pin Output	Description	Connector
1	LMT +5V	+5V supply input for optical limit switch boards (the typical requirement is 50 mA).	
2	LMT COM	Common ground to limit switch.	
3	CW/+ LMT	Signal indicating maximum travel produced by positive/CW stage direction.	
4	Home LMT	Home reference limit output	
5	CCW/-LMT	Active high signal indicating stage maximum travel produced by negative/CCW stage direction.	
6	SIG SHLD	Signal shield connection	
NOTE: Pins not shown are reserved.			

Table 3-19: Limit Switch Mating Connector

	Aerotech P/N	3rd Party P/N
Backshell	ECK01021	Amphenol DE24657
Connector	ECK00340	Cinch DE-9S

Chapter 4: Maintenance

This chapter will cover information about component maintenance and replacement, intervals between lubrications, detail the lubrication and inspection process, and cover which lubricants are recommended for use. The AGR series stages are designed to be low maintenance positioning systems, however periodic lubrication and cleaning is required to ensure long term reliability.

DANGER: To minimize the possibility of bodily injury or death, disconnect all electrical power prior to making any mechanical adjustments.

4.1. Service and Inspection Schedule

Lubricant inspection and replenishment in AGR series stages depends on conditions such as duty cycle, speed, and the environment. An inspection interval of once every two weeks is recommended until a trend develops for the application. Longer or shorter intervals may be required to maintain the film of lubricant on the worm threads. In general, it is recommended that stages operating in a clean environment at 50% duty cycle or less be lubricated monthly, or every 75,000 revolutions, which ever comes first. For long-term reliability, we recommend that you return the stage to Aerotech after 300,000 rotation cycles for cleaning, relubrication, and gearing adjustments. For stages operating at higher duty cycles, lubrication once every two weeks is recommended.

If the application process uses only a small portion of travel for most of the duty cycle, it is recommended that the stage be periodically driven through full travel to redistribute the lubrication in the bearings and worm drive. For high-speed applications (i.e., near maximum speed at a duty cycle of 50%), frequent worm thread maintenance with standard lubricants is required. The worm shaft end bearings and motor bearings should not need to be relubricated under normal use.

Visually inspect the stage, motor, and cables once per month.

- Re-tighten loose connectors.
- Replace or repair damaged cables.
- Clean the stage, motor, and cables if needed.
- If the stage or motor is damaged have it repaired before using.

4.2. Cleaning and Lubrication

If a solvent is necessary for cleaning the stage, isopropyl alcohol should be used.

For the worm gear drive mechanism, Klubersynth BEM-44-461-US grease is the only approved lubricant for standard stages.

4.2.1. Recommended Cleaning Solvents

Before using a cleaning solvent on any part of the stage, it is recommended that compressed nitrogen or clean, dry air be used to blow away small particles and dust. Any metal surface of the stage may be cleaned with isopropyl alcohol on a lint-free cloth.

4.2.2. Lubrication Procedure

The AGR series of rotary stages is designed for easy maintenance of the worm drive system. The drive mechanism may be lubricated while the stage is under power and integrated in upper level systems providing access to the lubrication ports are maintained. Access to the lubrication ports are provided by removing the port cover screws shown in Figure 1-2. Prior to removing the screw, make sure the surrounding surface is clean.

While the stage rotates (<5 rpm), slowly inject approximately 6 cc's of lubricant into the ports. Wipe clean any excess lubricant and reinstall the port cover screws.

Figure 4-1 shows the effect of the addition of lubricant to the current draw of a typical AGR stage. With the added lubricant the resulting current pull is much smoother, leading to much better mechanical performance and maximum life of the product.

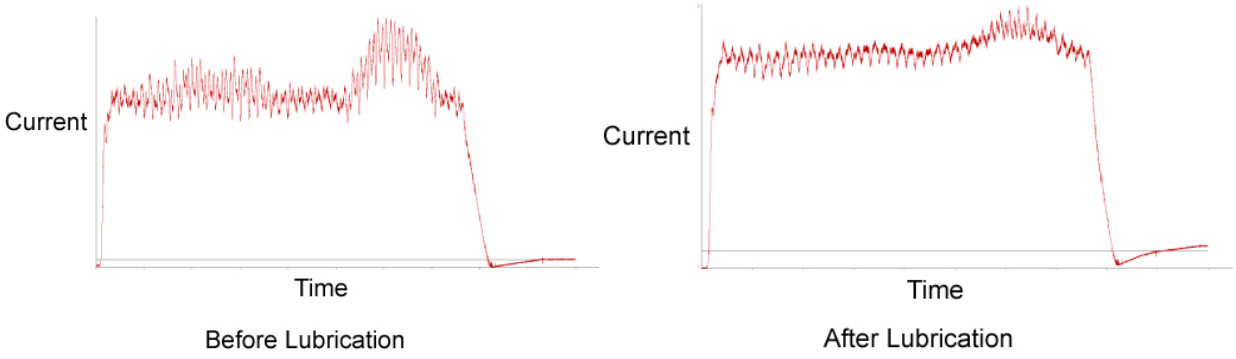


Figure 4-1: View of the Current Draw of a Typical AGR Stage Before and After Lubrication

4.3. Troubleshooting

This section provides some information regarding typical stage related problems.

Table 4-1: Troubleshooting

Symptom	Possible Cause and Solution
Stage will not move.	Brake not released (If equipped with brake). See stage documentation. In Limit condition. Check limits. Also refer to controller documentation for polarity and compatibility requirements (Example: voltage requirements). See Section 3.5. Controller trap or fault. See controller documentation.
Stage moves uncontrollably	Encoder (sine and cosine) signals connections. See Section 3.4. and Controller documentation. Motor Connections. See Section 3.4. and Controller documentation.
Stage oscillates or squeals	Gains misadjusted. See Controller documentation. Encoder signals. See Controller documentation.

Appendix A: Stepper Motor Removal

Step 1: Ensure power has been removed from the system.

DANGER: To minimize the possibility of bodily injury or death, disconnect all electrical power prior to making any mechanical adjustments.

Step 2: Remove caps and unscrew socket head cap screws that are opposite of the motor stud locations.

Step 3: Remove the motor can and disconnect the 6-pin limit wire connector.

Step 4: Loosen the Motor Coupling via the access hole on top of the drive housing or the additional access hole that is located under the top cover on the main housing.

Step 5: Dismount the motor by removing the two M3 Hex Nuts that hold the motor to the motor mounting adapter.

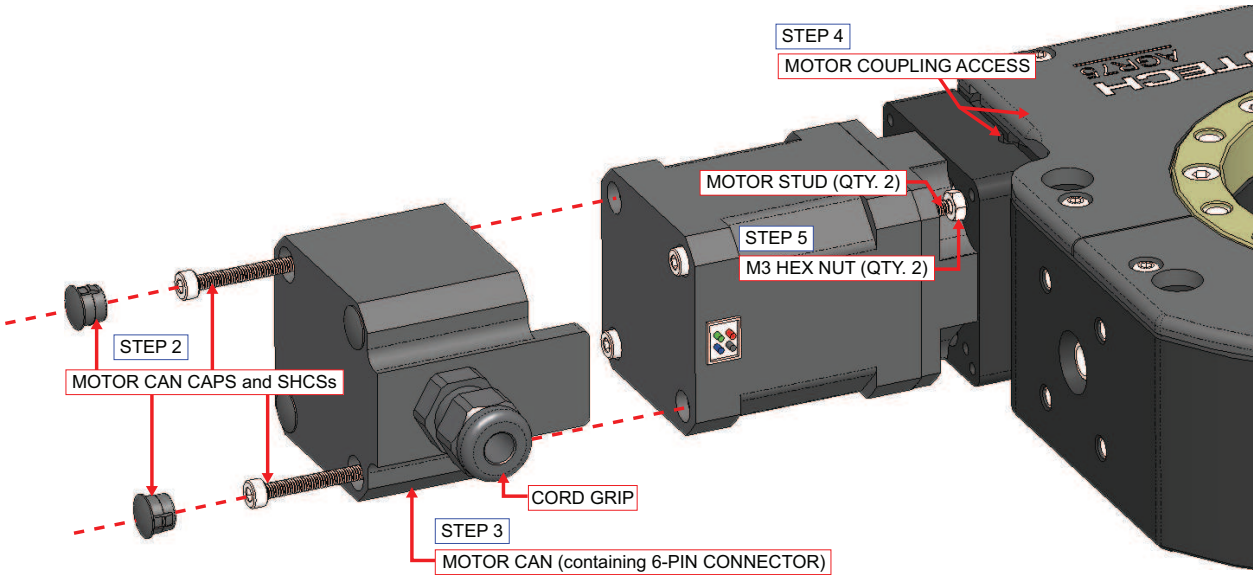


Figure A-1: Stepper Motor Removal

Appendix B: Warranty and Field Service

Aerotech, Inc. warrants its products to be free from defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech's liability is limited to replacing, repairing or issuing credit, at its option, for any products that are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, where or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech's products are specifically designed and/or manufactured for buyer's use or purpose. Aerotech's liability or any claim for loss or damage arising out of the sale, resale or use of any of its products shall in no event exceed the selling price of the unit.

Laser Products

Aerotech, Inc. warrants its laser products to the original purchaser for a minimum period of one year from date of shipment. This warranty covers defects in workmanship and material and is voided for all laser power supplies, plasma tubes and laser systems subject to electrical or physical abuse, tampering (such as opening the housing or removal of the serial tag) or improper operation as determined by Aerotech. This warranty is also voided for failure to comply with Aerotech's return procedures.

Return Procedure

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within (30) days of shipment of incorrect materials. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. Any returned product(s) must be accompanied by a return authorization number. The return authorization number may be obtained by calling an Aerotech service center. Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than (30) days after the issuance of a return authorization number will be subject to review.

Returned Product Warranty Determination

After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warranted defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an airfreight return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

Returned Product Non-warranty Determination

After Aerotech's examination, the buyer shall be notified of the repair cost. At such time, the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number or approval within (30) days of notification will result in the product(s) being returned as is, at the buyer's expense. Repair work is warranted for (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

Rush Service

At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech's approval.

On-site Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty-related, then the following policy applies:

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material.

If service is rendered at times other than normal work periods, then special service rates apply. If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following "On-Site Non-Warranty Repair" section apply.

On-site Non-warranty Repair

If any Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies:

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.

Company Address

Aerotech, Inc.
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Pittsburgh, PA 15238
USA

Phone: 412-963-7470
Fax: 412-963-7459

Appendix C: Revision History

Revision	Date	General Information
1.03.00	May 14, 2013	• General overhaul revision • Updated wiring section: Section 3.4. • Dimension section added: Section 1.4. • Added new section: Stepper Motor Removal
1.02.00	March 8, 2011	• Limit switch wiring figure updated: Section 3.5.1. • Dust and water exposure requirements updated: Section 3.1. • Figure updated to show new lubrication port: Section 4.2.2.
1.01.00	February 2, 2011	• Section added: Section 1.6. • Section added: Section 3.1. • Safety information and warnings added and updated • Motor specifications added, Continuous Current rating updated: Section 3.2. • Note about motor wire current and voltage requirements added: Section 3.4. • Added limit switch diagram and pin assignment table: Section 3.5.1.
1.00.00	April 2, 2009	New Manual

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